THE YUMA DESALINIZATION PLANT

ARIZONA PERSPECTIVES

AUGUST 2002

Arizona Department of Water Resources

The Yuma Desalinization Plant
Arizona Perspectives
2002

TABLE OF CONTENTS

FIGURES AND TABLES

Acknowledgements

This report was prepared by the Arizona Department of Water Resources, Thomas Carr, author, and Deanna Ikeya, Technical Support. In addition, ADWR staff members Michael Hanrahan, PhD, Agricultural Economist, and Randal Edmond, Water Resources Manager, reviewed the report. The Department also greatly appreciates the comments and suggestions on the draft report provided by Thomas McCann, Attorney, and Larry Dozier, Deputy General Manager, Central Arizona Water Conservation District.

The Yuma Desalinization Plant

Arizona Perspectives

Preface

The purpose of this report is to explain the rationale and justification of Arizona policy positions regarding the Yuma Desalinization Plant and bypass flows to Mexico. Arizona is concerned that Reclamation take appropriate actions that protect Arizona's apportionment of Colorado River water from shortages as it manages the river to meet the salinity requirements of Minute 242 of the 1944 Treaty with Mexico. Historical background is presented to explain the purpose of the development of the Colorado River Basin Salinity Control Program, and the role of the Yuma Desalinization Plant in the management of the water supplies of the Colorado River to meet the Mexican Water Treaty deliveries. The report also includes an evaluation of some of the potential economic impacts due to water supply shortages to Arizona water users if the plant is not operated.

Generally, the report concludes that the Yuma Desalinization Plant must be operated to reclaim saline water that is being bypassed to Mexico. The loss of this water from the Colorado River system creates an increased probability of water supply shortage to Arizona. Operation of the plant is therefore necessary to avoid direct and indirect impacts to Arizona water users. Nearly 30 years ago, the desalter was chosen as part of the permanent solution to solve salinity issues at the international border with Mexico. Since that time, many water allocation and investment commitments have been made within Arizona based on this federal policy. The federal government may, for a few years, postpone the operation of the plant by retiring agricultural water uses in Arizona and California. However, the costs associated with agricultural land retirement are high as evidenced by the recent actions in California, so postponement of the operation has little economic benefit. Using water to meet the federal treaty obligation will soon interfere with the growing water demands within Arizona. The Central Arizona Project projects that water demand will exceed the available supply in 2003 because its customers will need water to offset drought conditions on the Salt River. If that is the case, no water will be available from Arizona and the plant will have to be operated to meet the federal obligations under federal law.

Introduction

The U.S. Bureau of Reclamation (Reclamation) reports that Congress has asked for information about the plans for operation of the Yuma Desalinization Plant (desalter). The request was included in the 1999 report from the U.S. Senate Appropriations Committee. The Lower Colorado River Regional Director has indicated that he intends to use this reporting opportunity to propose alternatives to the operation of the desalter. The Regional Director has said that if the proposals are not acted upon by Congress within sixty days after the report has been submitted to the appropriate committees of Congress, then the proposals may be adopted by Reclamation pursuant to Section 1574 of the Salinity Control Act of 1974 (Public Law 93-320). [1]

The purpose of the desalter is to reclaim drainage water from the Wellton-Mohawk Irrigation District so that it can be delivered to Mexico for beneficial use. In Minute 242 of the 1944 Treaty with Mexico, the United States agreed that the Colorado River water that was delivered to Mexico would meet certain salinity standards. Because the saline return flow from the Wellton-Mohawk District exceeded those standards, the U.S. agreed temporarily to bypass those flows around the Mexican diversion at Morelos Dam. These bypass flows, which have averaged more than 100,000 acre-feet per year, are not counted as part of the 1,500,000 acre-feet of water that must be delivered pursuant to the Treaty. Delivery of water to Mexico in excess of the treaty requirements depletes the contents of the Colorado River reservoir system, which will cause an increased frequency of water supply shortages to the U.S. The majority of the shortage impacts will be borne by Arizona water users because the Central Arizona Project is junior to all other water users in the Lower Basin. By reclaiming the drainage water, the U.S. will not have to over-deliver to Mexico to meet the international salinity agreements and thus reduce depletion of water from the reservoirs, making the U.S. water supplies more dependable.

The desalter is only one part of a very large U.S. program to control salinity of the Colorado River so that downstream water users, and Mexico in particular, can receive water of adequate quality. The Colorado River Basin Salinity Control Program as authorized by Congress has expended hundreds of millions of dollars to implement salinity control programs to meet the Mexican Treaty requirements. One of the last features of the salinity control program is to operate the desalter so as to guarantee that U.S. water supplies are protected.

Congress provided in the Salinity Control Act that the Wellton-Mohawk drainage water could only be bypassed as long as the Lower Basin States were not using their full entitlements. Congress also directed Reclamation to build the desalter as the "permanent solution" to reclaim the Wellton-Mohawk drainage so that water could be delivered to Mexico as part of the Treaty apportionment. (Brownell, 1972). All of the states, but Arizona in particular, relied upon U.S. guarantees that the Colorado River water supply would be protected. U.S. water demands have now grown to a point

---

[1] §1574. Modification of projects
The Secretary is authorized to provide for modifications of the projects authorized by this subchapter to the extent he determines appropriate for purposes of meeting the international settlement objective of this subchapter at the lowest overall cost to the United States. No funds for any such modification shall be expended until the expiration of sixty days after the proposed modification has been submitted to the appropriate committees of the Congress, unless the Congress approves an earlier date by concurrent resolution. The Secretary shall notify the Governors of the Colorado River Basin States of such modifications.
(Pub.L. 93-320, Title I, § 104, June 24, 1974, 88 Stat. 270.)

that the lower basin water demands are in excess of the compact apportionments, while the upper basin demands continue to steadily grow.

Arizona is concerned that continuation of the bypass flows to Mexico in excess of the treaty requirements will cause significant damages to the future welfare and economy of Arizona. The U.S. needs to take immediate action pursuant to the original authorization and intent of the Salinity Control Act to reduce losses of the water supplies of the Colorado River. The actions that the U.S. must take have to be consistent with over thirty years of negotiations, agreements and federal investments including the construction of the desalinization plant. Arizona has analyzed alternatives to operation of the desalter in the context of the historical precedents and still finds that it is the best solution to protect the lower basin water supplies. In the short-term, partial operation of the desalter up to one-third of capacity and acquisition of water for delivery to Mexico through water conservation programs in the U.S. might be feasible, but the permanent solution still requires water supply reclamation through desalinization.

PART 1 – HISTORICAL BACKGROUND

Overview

Salinity problems on the Colorado River have been studied, discussed and negotiated by numerous individuals and agencies for decades. The evolution of the international agreements illustrates the complexities of the water quality problems and the rational development of the solutions. The agreements attempted to balance the conflict between water users in Mexico who desired adequate quality, and U.S. water users who wanted to conserve reservoir supplies to protect against shortages. The U.S. water users expected that all downstream water users including Mexico would have to accept return flows as part of the overall supply. But Mexico refused to accept lower quality return flows from up-stream water diverters. Instead, Mexico requested that higher quality water be delivered from reservoir storage to replace lower quality return flows.

The solutions to the international salinity problem included establishing a salinity standard acceptable to Mexico, reducing return flows to reduce salinity loading and reclaiming the return flows that were of unacceptable quality. It has taken several decades and hundreds of millions of dollars to implement the programs agreed to by Mexico and the U.S. The final step is operation of the desalter.

Water Management Objectives – U.S. v. Mexico

In the early 1970's, the basin states were willing to cooperate to find a solution to the salinity problem, but from their perspective, the solution could not include a permanent commitment to deliver water in excess of the Mexican treaty requirements. The basin states did support interim deliveries to Mexico while the permanent solutions were being implemented (Holburt, 1975).

Mexico's position at the time was that it was entitled to the same quality of water as Imperial Valley, California. Mexico also wanted compensation for salinity damages caused by the Wellton-Mohawk drainage flows.

Many different solutions to the salinity problem were analyzed to resolve these conflicting water management objectives. Several solutions were rejected because unacceptable impacts would occur to the Mexican or U.S. interests. The final solution was a compromise. Mexico agreed to some increase in salinity. The U.S. agreed to spend money to improve the overall quality of Colorado River water and to protect the U.S. water supplies (Holburt, 1975).

The water management objectives of both countries have changed little since 1972: Mexico needs acceptable quality water; U.S. water users in the basin states still need to minimize the impacts on the water supply. However, one additional water management objective is now under discussion by both countries. The International Boundary Water Commission has agreed in Minute 306 to the Mexican Treaty to study the need for water for environmental purposes in the Mexican delta of the Colorado River (IBWC, Minute 306).

This new international study emphasizes the increasing demand for water in the lower Colorado River basin and the emergence of environmental water as a beneficial use in Mexico. This new

water use was not foreseen by the negotiators but would have only emphasized the water supply limitations in the lower Colorado River basin.

The history of the salinity problem illustrates that the negotiators considered the impacts of the all of their actions and adopted the solutions as a comprehensive program. Any changes to the intended program, especially in light of the emerging environmental water demands, will have impacts on the availability of water to support the water demands of the states.

Summary of History

Three historical milestone agreements form the basis of current U.S. water management policies regarding salinity issues at the international boundary: Minute 218 of the 1944 Treaty with Mexico and the actions taken to implement its provisions; Minute 241 of the Treaty and the subsequent Brownell report of 1972; Minute 242 of the Treaty and implementation actions contained in the Salinity Control Act of 1974. These milestone agreements consistently reinforce the notion that bypassing water in excess of the treaty requirements is not a permanent solution to the salinity problem primarily due to the impact on U.S. water users.

Minute 218 of the Treaty with Mexico

In 1961, the Wellton-Mohawk Irrigation District commenced discharge of saline drain water from wells to the Colorado River via the Gila River. Concurrently, water deliveries to Mexico dropped from an average of 4.2 million acre-feet per year to 1.5 million as Lake Powell was filled. The loss of diluting flows from the mainstream severely exacerbated the impacts of the increases in saline return flows. The salinity conditions of the Colorado River caused the U.S. and Mexico to begin extensive negotiations over a three-year period. In 1965, Minute 218 was adopted to the 1944 Treaty. The Minute was a five-year agreement (Holburt, 1975). The primary provisions of the Minute were:

1. Construction of an extension of the Wellton-Mohawk Drain so that drainage water could be either bypassed around Morelos Dam or mixed with other Colorado River Water above Morelos Dam, at the option of Mexico.
2. Construction of additional drainage wells in the Wellton-Mohawk Project which allowed selective pumping of the most saline waters at times when Mexico would be bypassing Wellton-Mohawk drainage water, and allow the pumping of higher quality groundwater at times when Mexico would be using Wellton-Mohawk water.
3. Replacement of a portion of the bypassed Wellton-Mohawk water, which resulted in the release of approximately 40,000 acre-feet of mainstream water per year from Imperial Dam in excess of the 1.5 million acre-feet per year guaranteed by the treaty.

Although the actions taken pursuant to Minute 218 reduced the salinity of the water delivered to Mexico, the interim measures agreed to for the five-year term were not deemed sufficient by Mexico. Negotiations began for another limited term agreement to replace Minute 218 with an agreement that was more satisfactory. The U.S. negotiators proposed that a salt balance be maintained in the Yuma area, so that the water delivered at Morelos contained only the concentration of salt that would have existed if the Yuma districts were in salt balance. This solution would have

resulted in a salinity differential of 270 parts per million (PPM) between Imperial Dam and Morelos Dam. Mexico rejected this agreement (Holburt, 1975).

Minute 241 and the Brownell Report of 1972

In 1972, President Nixon agreed to undertake certain immediate actions to improve the quality of water going to Mexico. He also agreed to designate a special representative to find a permanent, definitive and just solution of the salinity problem. The report was due by the end of 1972, and upon approval by the U.S. government, it was to be submitted to President Echerverria of Mexico for consideration and approval (Holburt, 1975).

Minute 241 described the immediate actions to be taken by the U.S. Based on a salt balance concept, the U.S. agreed, as an interim measure, to bypass 118,000 acre-feet of water from the Wellton-Mohawk District and to substitute waters from the Colorado River mainstream and pumped water from the Yuma Mesa on an interim basis. Additionally, Mexico chose to bypass the rest of the Wellton-Mohawk drain water, an amount exceeding 95,000 acre-feet in 1973. Bypassing over 200,000 acre-feet of water in 1973 allowed Mexico to receive water with a mean quality of 980 PPM, or about 130 PPM higher than the water arriving at Imperial Dam for the same period (Holburt, 1975).

Ambassador Herbert Brownell was appointed as the special representative of the President of the U.S. to prepare a report on the permanent and definitive solution to the international problem. The recommendations of the Brownell Report led directly to adoption of Minute 242 and the 1974 Salinity Control Act.

Brownell listed several principle issues that required solutions. The first issue was that Mexico and the U.S. had to agree to an acceptable salinity differential between Imperial Dam and Morelos Dam. He believed that a negotiated agreement could only be reached if both countries cooperatively developed other technical programs that would mitigate existing and future salinity damages. The list of technical programs that needed to be developed included improving farm management and irrigation practices in Mexico, managing the salinity of the Colorado River system as a whole, and augmenting the water supply to meet the long-term projected water needs. Desalting using energy from geothermal development or nuclear power was specifically described as part of the augmentation program. In addition to the issues of salinity management, Brownell reported that the development of a well field near San Luis Mexico was a water supply issue for the U.S.(Brownell, 1972).

The Brownell report recommended that a negotiated solution would be in the best interests of all, because the technical and legal differences of opinion would have unduly prolonged any adjudicated solution. The report also acknowledged that the solutions were expensive and would require significant time to implement. Therefore to provide for prompt relief to Mexico, the report recommended a set of interim and permanent solutions.

The interim solution in the Brownell Report read, in part:

1. Continuation of delivery of a total of some 120,000 acre-feet of water from Yuma Mesa pumping and Imperial Dam storage in substitution for a like amount of Wellton-Mohawk

return flows, as under Minute 241, until water from the Coachella salvage becomes available, or the permanent solution can be implemented.

2. Relocation and lining of a portion of the Coachella Canal in California under a cost-sharing arrangement between the Federal Government and the Coachella Valley County Irrigation District to salvage some 130,000 acre-feet of water per year for temporary Federal use in an interim solution…The District and the appropriate authorities of the State of California have expressed their concurrence in the use by the United States of the water which could be salvaged and in the reduction of diversions to the Coachella Canal by a like amount until California's Colorado River diversions are reduced to 4.4 million acre-feet annually – that is, most likely until the Central Arizona Irrigation Project begins diversion…

3. Steps to reduce the irrigated acreage at Wellton-Mohawk to as near 60,000 acres as proves practical under an incentive program…The purpose of this action, together with steps to increase the irrigation efficiency on irrigated lands at Wellton-Mohawk described below, would be to reduce both water diversion to Wellton-Mohawk and drainage from Wellton-Mohawk by at least 40,000 acre-feet – and more if found practical – by 1978. Reduction of the drainage would reduce the financial cost of the desalting plant, which is the core of the permanent solution, and also the water cost resulting from substitution for the brine effluent from desalting…

4. Maximum practical efforts to improve Wellton-Mohawk District on-farm irrigation efficiency, as worked out cooperatively among the Departments of Interior and Agriculture, the Environmental Protection Agency and the District.

The permanent solution as described in the Brownell Report read, in part:

> The recommended permanent solution is desalting of Wellton-Mohawk drainage by a membrane process desalting plant to be in full operation by 1978. …The result of the above-described interim and permanent actions would be that by 1978 the salinity of Wellton-Mohawk District drainage water would no longer affect Mexico. With the removal of the effects of Wellton-Mohawk drainage, Mexico should be able to use without difficulty the drainage, salvage, and other such waters as the United States has been delivering and expects to deliver as a part of Mexico's treaty allotment.

Certain 'allied actions' were proposed to address all of the principal issues that were outlined in the report. As stated in the report:

1. An agreement between the United States and Mexico on groundwater pumping.
2. Full implementation of the…arrangements…for exchange of information and technical expertise on desalting and geothermal development.
3. Additional arrangements for exchange of information and technical expertise on farm management and irrigation practices in the Colorado River Basin…
4. Timely decisions in regard to implementation of specific actions to control salinity increases in the Colorado River Basin.
5. Continuation of efforts to achieve augmentation of the Colorado River.

Minute 242 and the Salinity Control Act of 1974

After completion of the report, Brownell negotiated the final agreement on the salinity differential with Mexico. The two countries incorporated the agreement into Minute 242, which was signed in 1973. The maximum agreed upon differential is similar to that which existed in 1973 at the time of the adoption of the minute. The minute reads in part:

1. (a) The United States shall adopt measures to assure that not earlier than January 1, 1974, and no later than July 1, 1974, the approximately 1,360,000 acre-feet delivered to Mexico upstream of Morelos Dam, have an annual average salinity of no more than 115 PPM +/- 30 PPM U.S. count over the annual average salinity of Colorado River waters which arrive at Imperial Dam, with the understanding that any waters that may be delivered to Mexico under the Treaty of 1944 by means of the All American Canal shall be considered as having been delivered upstream of Morelos Dam for the purpose of computing this salinity.

2. ... From September 1, 1973, until the provisions of point 1(a) become effective, the United States shall discharge to the Colorado River downstream from Morelos Dam volumes of drainage waters from the Wellton-Mohawk District at the annual rate of 118,000 acre-feet and substitute therefor an equal volume of other waters to be discharged to the Colorado River above Morelos Dam; and, pursuant to the decision of President Echeverria expressed in a Joint Communiqué of June 17, 1972, The United States shall discharge to the Colorado River downstream from Morelos Dam the drainage waters of the Wellton-Mohawk District that do not form a part of the volumes of drainage water referred to above, with the understanding that this remaining volume will not be replaced by substitution waters. The Commission shall continue to account for all drainage waters discharged below Morelos Dam as part of those described in the provisions of Article 10 of the Water Treaty of February 3, 1944.

The measures to implement the interim and permanent solution as proposed by Brownell and referred to in Minute 242 were authorized by Congress in the Salinity Control Act of 1974. The measures included authorization of the construction of the desalter to reclaim the water that was required to be bypassed by Minute 242 and extension of the Wellton-Mohawk drain to the Cienega de Santa Clara. It also authorized the lining of Coachella canal as an interim measure to salvage water to substitute for the bypassed water during an interim period. The legislation clearly states that replacement of the bypassed drainage water and brine reject stream from the desalter is a federal obligation. Measures to reduce the drainage flow from the Wellton-Mohawk District through land retirement and conservation were authorized. The legislation capped the District's return flow. Finally, projects were authorized under Title II of the Act to reduce salt loading upstream from Imperial Dam (Pub.L. 93-320).

At the time of the legislation, it was expected that the Wellton-Mohawk District would reasonably be able to reduce its drainage flow from 250,000 acre-feet to 175,000 acre-feet per year. However, through a combination of land retirement and system improvements the return flows were reduced to below 125,000 acre-feet by 1995 (USBR).

Congressman Harold T. Johnson of California and eleven other basin state congressmen introduced the Salinity Control Act (H.R. 12165). The importance of replacing the bypass flows to Mexico was emphasized in congressional testimony on the Act. Congressman Johnson testified, "Since the water being over-delivered to Mexico is being taken from the flows of the Colorado River that are, by compact, the entitlement of the seven States of the basin, there is clear and present need to reduce the over-delivery and to identify a source of replacement water for that being over-delivered. The domestic thrust for this legislation rises from this fact." The desalting plant was intended to replace part of the water. Other augmentation projects were intended to replace the brine reject stream from the plant (U.S. Congress, 1974).

The Colorado River basin states united in their support of the "permanent, definitive and just solution" to the salinity problems with Mexico because the Salinity Control Act contained assurances that there would not be an unacceptable risk of loss of basin water supplies. Key to the entire salinity control package was the desalter, which provided the basis of the assurances. In 1979, representatives of the governors of the basin states testified to Congress:

> "The Basin States, faced with an already over committed river, insisted that the concessions granted to Mexico be achieved without cost to the Basin States in dollars, water or energy. The States could not afford to accept loss of any of their Colorado River Basin water resources, including unusable brines wasted from the desalting plant and water bypassed during occasional periods of inoperability of the plant. We stressed, therefore, that it was imperative that the United States assume and effectuate an obligation to build the desalting plant as a National obligation and to replace at its cost any water loss caused by its operation. The Committee of Fourteen in its frequent contact with special Ambassador Brownell and the State Department during the negotiations with Mexico was assured consistently of total and absolute protection against the loss of Colorado River Basin water resources." (U.S. Congress, 1979).

U.S. Salinity Control Programs 1974 – Present

The Salinity Control Act of 1974 authorized: the construction of the desalter; extension of the bypass drain to carry the brine reject stream from the desalting plant and other drainage waters to the Cienega de Santa Clara (a.k.a. Santa Clara Slough) in Mexico; acquisition of irrigated acreage in the Wellton-Mohawk District and improvements in irrigation efficiencies in the district to reduce return flows; replacement water studies to identify sources of water within the Colorado River basin to replace the reject stream from the desalter; the Colorado River Basin Salinity Control Program to reduce salt discharges to the Colorado River from mainly the upper basin; and, lining of the Coachella Canal in California to offset the bypass flows until the desalter was operational. Congress also authorized the construction of a well field along the Arizona and Mexico border to be used as a water source to meet the Mexican Treaty requirements and other water demands in the U.S.

Extension of the Bypass Drain

The bypass drain was completed in 1978. The bypass drain is a continuation of the Main Outlet Drain Extension that conveys water from the Wellton-Mohawk District to the Southerly International Border near the intersection of the Arizona-Mexico borderline and the Colorado River. The drain extends into Mexico and ends very near the Sea of Cortez, east of the Colorado River channel. (See Figure 1) (USBR, 2002)

Reduction in Return Flows from the Wellton-Mohawk District

The Act required return flows from the Wellton-Mohawk District to be reduced to at least 175,000 acre-feet. To accomplish this objective, Congress authorized the retirement of 10,000 acres of irrigated land within the Wellton-Mohawk District and intensive water conservation on the remaining 65,000 acres of farmland.

By 1975 Reclamation had identified the lands to be retired and by 1978 the acquisition was completed. Approximately 6,300 acres of privately held lands and 3,700 acres of federally owned lands were retired from irrigation. Reclamation's objective was to reduce drainage return flows from lands with the lowest irrigation efficiencies and greatest return flow (USBR, 1977).

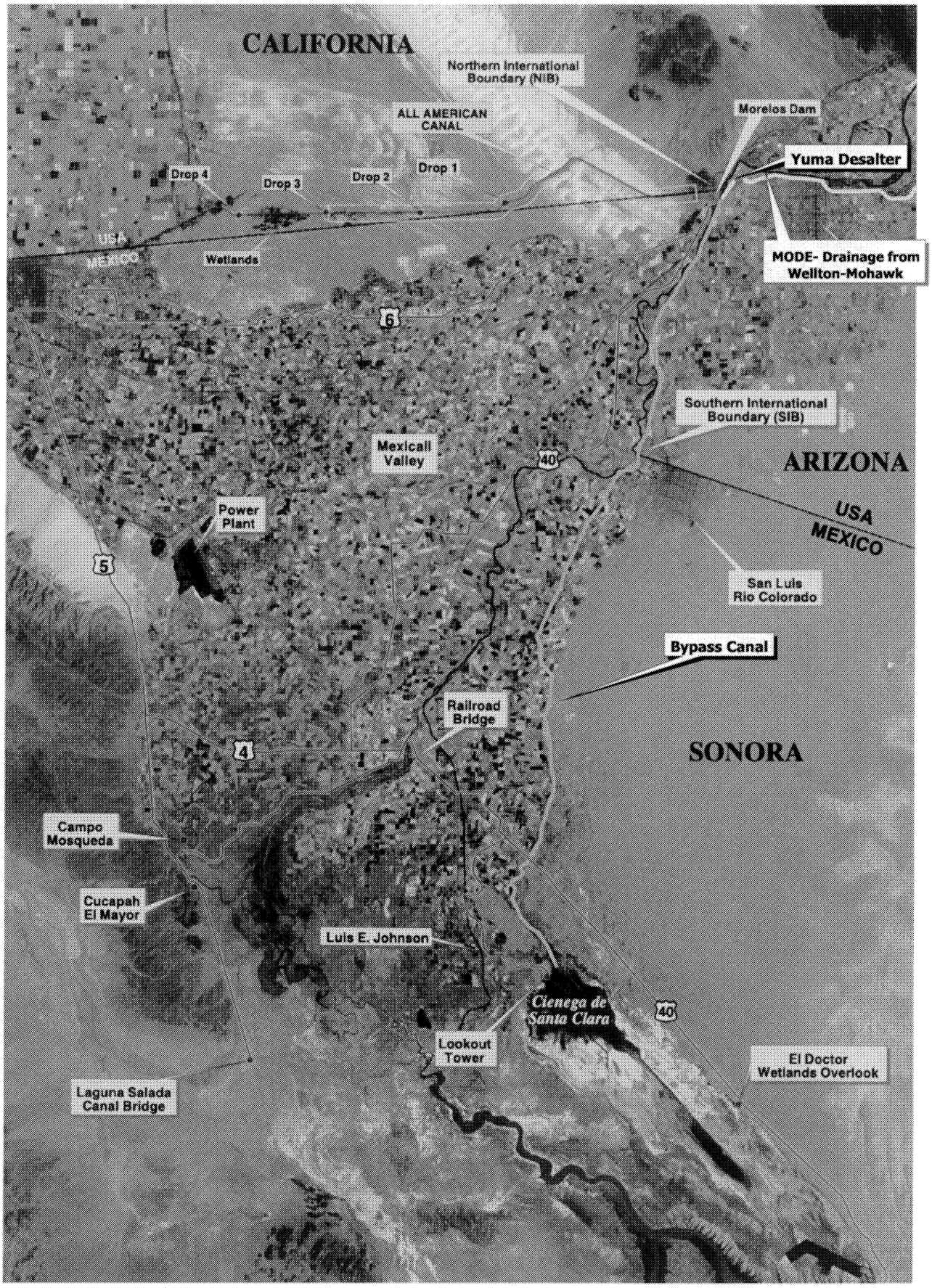
To further reduce return flow, an intensive on-farm water conservation program was initiated by the U.S. Department of Agriculture, Soil Conservation Service. The agency opened a field office in 1975 to provide on-farm improvements and consultations to improve the overall water use efficiencies on the remaining 65,000 acres of irrigated land in the District. Between 1975 and 1986 the field office assisted with the leveling of fields, lining of ditches and on-farm irrigation water management practices (USDA-SCS, 1988).

The resulting land retirements and irrigation system improvements reduced reported drainage flows from 206,000 acre-feet in 1974 to 118,500 in 1986. Between 1986 and 2000 the return flows varied from a low of 91,000 acre-feet to as much as 147,000 acre-fee (USBR). The U.S. Department of Agriculture projected that the irrigation improvements would reduce return flows to approximately 136,000 acre-feet.

Construction of the Yuma Desalinization Plant

Construction of the desalter began in approximately 1980 and was completed in 1992. The cost of construction was $256 million. At full operation the plant is expected to desalt 97,000 acre-feet of influent at 3,200 PPM of total dissolved solids. Output from the plant would be approximately 68,500 acre-feet of pure water. The plant product water could then be blended with 11,000 acre-feet of water from the Wellton-Mohawk District for a total product output of 79,500 acre-feet at salinity levels in the range of 600 to 800 PPM. Approximately 28,500 acre-feet of brine reject stream would also be discharged as waste. At full operation, 108,000 acre-feet of drain water would be needed to produce 79,500 acre-feet of product water (97,000 ac-ft for the plant + 11,000 ac-ft for the blend) (USBR, 2002).

The plant was operated for eight months and then put on standby status in 1993. In the 1995 Water and Energy Appropriations bill, the House Appropriations Committee approved Reclamation's request to maintain the desalter in ready reserve with instructions to be able to operate one-third of



ARIZONA DEPARTMENT OF WATER RESOURCES

N
W E
S

Landsat Image
June 1998

BypassCienegaProject

the plant within a one-year time period (U.S. Congress, 1995). In 1999, the Senate Appropriations Committee recommended deferring the replacement of the membrane filters due to budgetary constraints (U.S. Congress, 1999). The Committee noted the high cost of standby, over $10 million per year. They requested a report to the Committee on alternatives to meeting the Treaty requirements without the desalting plant, and actions Reclamation could take to reduce the high annual operation and maintenance costs. In its 2003 appropriations request, Reclamation has indicated that "(r)esearch advancements have already reduced projected full plant operation costs from $32,000,000 to $22,000,000". The appropriations report states that standby costs are now estimated at $9.7 million. (However, conversations with the Yuma Area Office in 2002 indicate that less than $2 million is actually needed for standby operations.) The estimated costs for the operation of the desalter vary based on the cost of power. As recently as August 2002, Reclamation reported that the operational costs to be between $28 and $36 million (USBR, 2002).

Replacement Water Studies

The act states that replacement of any Wellton-Mohawk drainage water bypassed to the Santa Clara Slough is a federal obligation. At a minimum, if the desalter is operated, approximately 28,500 acre-feet of water will be discharged as effluent from the desalting plant. Currently, the bypass is approximately 100,000 acre-feet. Reclamation was required to complete studies to identify sources of replacement water by 1980. The studies included research to increase precipitation through weather modification. One research study was called Project Skywater predated the act. The Colorado River Pilot Project continued until the mid 1970's, followed by the Colorado River Augmentation Demonstration Project in the late 1980's. Apparently, no operational project resulted from the pilot projects.

Lining of the Coachella Canal

A replacement water supply was needed until the desalter was completed and a long-term replacement for the brine reject stream was found. Brownell proposed that the first forty-nine miles of the Coachella Canal be lined to conserve most of the water lost to seepage and this suggestion was included in the authorized projects of the Salinity Control Act. It was estimated that 132,000 acre-feet of water would be saved. The lining project began in 1979 and was completed the next year (CVWD, 2002). The conserved water was intended to replace the over deliveries of water to Mexico until the desalter was completed and in operation and water was found to replace the brine reject stream from the plant. The U.S. was entitled to *temporary use* of the saved water to meet the salinity control objectives of Minute 242, *during an interim period.* The interim period began at the completion of the lining of the canal and was to end the first year that the Secretary delivered less water to California than was requested by the California water agencies and Federal establishments in California. In other words, once the 132,000 acre-feet of water were needed to meet the California demands, it would no longer be available to the Secretary. During the negotiations of Minute 242 and the Salinity Control Act, it was presumed that the interim period ended when California had to reduce their water use to the amount of water apportioned to California, which was assumed to be 4.4 million acre-feet. The end of the interim period is very important because it establishes the beginning of the time that the U.S. is obligated to replace the bypass flows to Mexico. The language of the Salinity Control Act is somewhat ambiguous, but the congressional record and other supporting testimony clearly explains the intent of the Act.

Colorado River Salinity Control Program

In addition to the projects to reduce the impact of return flows from the Wellton-Mohawk District on the water delivered to Mexico, the Salinity Control Act authorized an extensive program to reduce the overall salt loading of the Colorado River. The Colorado River Salinity Control Program is a jointly funded cooperative effort involving several federal agencies led by Reclamation and the basin states. The purpose of the program is to maintain or reduce the salinity levels of the Colorado River as the upper basin develops irrigation projects and other water uses. As part of the program, numeric salinity criteria were adopted by the Environmental Protection Agency at Hoover, Parker and Imperial Dams. Reclamation and the Department of Agriculture implemented salinity control projects in several tributary basins that reduced seepage from canals, saline water inflows from a variety of natural sources and return flows from farms. Since 1988, the Colorado River Salinity Control Program has invested $422 million of federal money, matched by up to 30% more from the basin states. Reclamation estimates that the salinity control projects prevent 775,000 tons of salt per year from entering the Colorado River (Colorado River Basin Salinity Control Forum, 2002).

Issues Remaining to be Resolved

Even though extensive progress has been made to implement the Salinity Control Act Programs to resolve the water quality problems at the international border, several important problems remain to be resolved.

Water Conservation Accounting

Beginning in 1980, water conserved by lining of the Coachella Canal should have been accounted as an offset to the bypass flows. If the estimated Coachella Canal conservation savings were less than the bypass, water deliveries to Mexico in excess of the Treaty should have been reported. However, Reclamation did not account for the canal savings, the excess water deliveries or the impact on the reservoir contents. In many years, the bypassed flows exceeded the estimated canal conservation savings and therefore depleted the water in storage. (See Table 1)

The bypass flows are not counted as a lower basin consumptive use because the Wellton-Mohawk District is credited with a return flow for the drainage water per its water delivery contract (USBR, 1990). But because the bypass flow is not delivered to Mexico as part of the Treaty water, it is effectively lost from the system. The water conserved by the lining of the Coachella Canal was intended to reduce the total lower basin consumptive use to offset the bypass.

Accounting for the impacts of the bypass flows on system storage is still an issue. As recently as 2001, Reclamation did not include explicit information in the Annual Operating Plan that explained the relationship of the Coachella Canal lining savings, bypass flows and impacts on reservoir contents caused by the bypass. Any alternative to the operation of the desalter that requires complex accounting procedures similar to the Coachella Canal conservation savings, will require significantly improved performance to be credible. An example calculation that illustrates the above description is included in Appendix A.

End of Interim Period vis a vis Coachella Canal Conservation Savings

The Salinity Control Act allowed Reclamation to use conservation savings from the Coachella Canal lining to make up for bypassed drainage water during an "interim period." Notwithstanding recent

Table 1
Record of Water Use and Bypass Flows

	Lower Basin CU	Unused Lower Basin Apportionment	Total Delivered to Mexico	River Operation		Water Bypassed	Canal Savings	Deficit Not Covered by Canal Savings	Cumulative Deficit Not Covered by Canal Savings	Coachella Water Use	Art. V WM MOD returns	
1964	6,217,206	1,282,794								526,417		
1965	5,931,234	1,568,766	1,687,661							524,686		
1966	6,196,307	1,303,693	1,615,612							489,429		
1967	6,021,832	1,478,168	1,558,977							464,053		
1968	6,276,133	1,223,867	1,562,737							478,583		
1969	6,073,590	1,426,410	1,565,784							495,082		
1970	6,254,767	1,245,233	1,528,504			54,682	0	54,682	54,682	449,263	213,990	
1971	6,563,708	936,292	1,506,414			55,208	0	55,208	109,890	464,445	210,350	
1972	6,514,729	985,271	1,526,234			86,304	0	86,304	196,194	511,426	206,630	Art.V bypass records pursuant to Minute 218.
1973	6,678,940	821,060	1,506,013			119,139	0	119,139	315,333	522,356	205,730	Art.V bypass records pursuant to Minute 241.
1974	6,834,560	665,440	1,506,173			159,185	0	159,185	474,518	558,864	206,400	Enactment of Salinity Control Act
1975	6,413,770	1,086,230	1,512,844			214,729	0	214,729	689,247	570,987	210,220	
1976	6,027,806	1,472,194	1,568,829			205,395	0	205,395	894,642	524,801	203,235	
1977	6,401,792	1,098,208	1,572,082			206,822	0	206,822	1,101,464	508,635	204,228	
1978	5,809,575	1,690,425	1,544,997			182,042	0	182,042	1,283,506	509,491	185,027	
1979	6,028,107	1,471,893	3,167,423			177,990	0	177,990	1,461,496	530,733	179,380	
1980	6,046,467	1,453,533	7,040,568	FC + M		154,630	132,000	22,630	1,484,126	531,791	192,695	Coachella Canal lining complete. Canal savings begin to accrue.
1981	6,314,245	1,185,755	2,042,472	FC + M		148,426	132,000	16,426	1,500,552	452,260	153,136	
1982	5,642,886	1,857,114	1,549,318	Normal		149,698	132,000	17,698	1,518,250	424,868	149,056	
1983	5,393,777	2,106,223	14,189,656	FC + M		179,157	132,000	47,157	1,565,407	362,266	138,785	
1984	5,888,553	1,611,447	15,493,017	FC + M		125,615	132,000	-6,385	1,559,022	355,789	124,373	
1985	6,074,596	1,425,404	11,811,298	FC + M		129,704	132,000	-2,296	1,556,726	337,002	121,047	
1986	6,273,876	1,226,124	10,794,077	FC + M		129,704	132,000	-2,296	1,554,430	337,144	118,522	
1987	6,734,996	765,004	4,646,483	FC + M		97,741	132,000	-34,259	1,520,171	332,635	123,712	
1988	7,091,836	408,164	2,330,711	FC + M		128,176	132,000	-3,824	1,516,347	331,821	128,602	
1989	7,530,327	Not Avail.	1,589,608	Normal		138,624	0	138,624	1,654,971	359,419	137,024	
1990	7,657,840	Not Avail.	1,541,988	Normal		133,667	0	133,667	1,788,638	369,685	138,170	
1991	7,050,179	449,821	1,520,873	Normal		140,684	132,000	8,684	1,797,322	317,563	147,270	
1992	6,601,513	898,487	1,580,732	Normal		101,109	132,000	-30,891	1,766,431	309,367	117,902	
1993	7,193,125	306,875	5,192,772	Normal		61,438	132,000	-70,562	1,695,869	318,990	130,354	No MOD breakout in Art. V before this date
1994	7,295,554	204,446	1,525,520	Normal		124,434	132,000	-7,566	1,688,303	326,102	94,788	MOD breakout in Art. V starts 1994. Unmeasured return flows credited to LB starting 1994.
1995	7,081,328	418,672	1,712,323	Normal		125,476	132,000	-6,524	1,681,779	326,697	121,490	
1996	8,027,466	Not Avail.	1,505,332	Surplus		112,391	0	112,391	1,794,170	331,473	119,620	
1997	8,100,911	Not Avail.	2,872,457	FC + M		89,154	0	89,154	1,883,324	338,028	91,700	
1998	7,620,606	Not Avail.	4,718,441	FC + M		113,769	0	113,769	1,997,093	337,466	98,410	
1999	7,976,394	Not Avail.	2,894,105	FC + M		78,675	0	78,675	2,075,768	333,810	95,300	
2000	8,038,303	Not Avail.	2,037,138	FC + M		107,444	0	107,444	2,183,212	329,367	110,280	
2001fcst	8,191,610	Not Avail.	1,670,307	Surplus		68,601	0	68,601	2,251,813	331,534	97,451	

statements by parties in California and some non-governmental organizations, the interim period is over and Reclamation is now obligated to replace all bypass flows (Center for Biological Diversity, 2001).

The Salinity Control Act provides that the "interim period...shall end the first year that the Secretary delivers main stream Colorado River water in an amount less than the sum of the quantities requested by (state and federal water users in California)." 43 USC § 1572(a). As explained in the legislative history of the Act, this was expected to occur "(w)hen the central Arizona project is completed and the State of California is obliged, in accordance with the terms of the Supreme Court decree in Arizona against California, to reduce its diversions from the Colorado River to 4,400,000 acre-feet annually." (U.S. Congress, 1974 and Brownell, 1972).

The interim period is best understood as an accounting issue under the Supreme Court decree in *Arizona v. California.* In a normal water supply year, the decree enjoins the Secretary from releasing more than 7.5 million acre-feet for use in California, Arizona and Nevada. Of that total, California is entitled to 4.4 million acre-feet plus any of Arizona or Nevada's unused apportionment that the Secretary makes available to it. These core elements of the Supreme Court decree were not altered by the Salinity Control Act.

Reclamation has previously acknowledged the 132,000 acre-feet of water conserved by the lining of the Coachella Canal is a part of California's 4.4 million acre-feet entitlement, which in turn is part of the 7.5 million acre-feet available to the lower basin states:

> "The water saved will represent a part of California's entitlement from the Colorado River, and may be used by agencies sharing in that entitlement. However, *until the water saved is required by those users,* it can be used to supplement or replace water from storage that will be released to Mexico and not counted as part of scheduled Treaty deliveries." (USBR, 1973).

The overriding point that is supported by the record is that water saved by lining the Coachella Canal must be accounted for within the 7.5 million acre-feet lower basin apportionment. As long as there is unused Arizona or Nevada apportionment available to California, water users in that state did not need to call upon the 132,000 acre-feet on loan to the Secretary and the Secretary was free to use the water to replace the water being bypassed to Mexico.

But in 1989 and 1990, lower basin water use exceeded 7.5 million acre-feet. California's water delivery orders could not have been met in those years without calling upon the 132,000 acre-feet of Coachella savings. Because California used the water, it was no longer available for replacing all of the drainage water bypassed to Mexico.

Even though the Secretary did not act in 1989 and 1990 to declare the interim period over, the Interim Surplus Guidelines have triggered limitations on water requests from California water users through the implementation of the benchmark quantities of water that restrict the water requests from the California irrigation districts. The districts have historically requested more water than allowed by the guidelines. Thus, through the guidelines, the Secretary has reduced the water requests from the districts and by doing so has ended the interim period (USBR, 2001).

Because the interim period is over, the Secretary is now required to replace any of the Wellton-Mohawk drainage water that is bypassed to Mexico.

River Operations to Meet Treaty Obligations

The public records containing the Article V reports do not fully explain the variations of reported flows to Mexico (see Table 1). It appears that, in some years, more water has been bypassed than has come from the Wellton-Mohawk drain wells. In other years, less. Reclamation has also reported that it adjusts well operations to avoid exceeding 1200 PPM daily salinity levels as a matter of practice, even though the Treaty does not require this practice. Apparently, some return flows to the river from districts other than the Wellton-Mohawk have been intercepted and bypassed via the main outlet drain extension (MODE) to Mexico. (Shown in Figure 1) By restricting the return flows from the Yuma water agencies, the total consumptive water use for the state may be overstated, creating an impact on CAP water supplies. Reclamation has not described the impacts of these operations on the water users or the water supply to date. Accurate and consistent accounting procedures are needed to accurately determine the size of the bypass obligation.

Protection of U.S. Water Supplies

Historically, the basin states representatives were united (some say for the first time) in their concern that the U.S. – Mexico water quality issues be resolved without an impact on basin water supplies and water users (DeMarsay 1991). Increased deliveries to Mexico mean reduced water supplies in reservoirs to offset low runoff years. Reductions in stored water lead to the increased probability of shortages to Arizona and to a much lesser degree Nevada and California. The CAP is the junior water entitlement holder on the river and will take the first and greatest reduction in a shortage year.

The upper basin states are impacted by over-deliveries to Mexico, too. If extra water is depleted from Lake Mead to offset the bypass flows, water may be released from Lake Powell to equalize the two reservoirs as required by the Long-range Operating Criteria for the Colorado River. Although not easily quantified, there is potential for long-term supply impacts to the upper basin.

Brownell was advised that all of the basin states opposed using unused upper basin apportionments to resolve the salinity issues with Mexico (De Marsay, 1991). To do so would have created a risk to the states that water apportioned to the states by the Colorado River Compact would instead be used to meet federal obligations. Some states felt that the Wellton-Mohawk District should have been retired, but the land owners of the district were not willing sellers. To force a sale upon unwilling participants would have created unwanted precedents with regards to the acquisition of water for federal purposes. For example, if water was needed for environmental purposes or to improve water quality, lands might be condemned and retired anywhere in the basin and the water apportionment used for purposes outside of the state. Such a precedent would severely impact each state's ability to manage water supplies apportioned to it by the Colorado River Compact. Nonetheless, significant acreage of irrigated land was voluntarily retired within the Wellton-Mohawk District to reduce return flows.

The desalter was intended to protect the states from water supply shortages caused by the bypass flows. But even the desalter operation required Reclamation to obtain additional water supplies to

offset the brine effluent losses of the desalter. Reclamation was directed to find substitute water supplies to offset the depletions of the Colorado River due to the loss of the brine stream. Again, Congress and the basin states did not want the federal government to reduce the apportionments of Colorado River water to the U.S. entitlements holders to resolve the water quality problems with Mexico. The statutory language that describes the interim period for use of the Coachella water conservation savings by the federal government illustrates the level of concern by the states about the potential competition from the federal government for water supplies. The Salinity Control Act clearly intended that no California water agency was expected to have to reduce its water uses as a result of the use of the water conservation savings from Coachella to offset the bypass flows. Rather, as soon as a California water agency restricted its water use, Reclamation was responsible for replacing the bypass flows.

Reclamation has not yet found a substitute water supply for the bypass or the effluent stream of the desalter that does not impact the availability of water for some entitlement holder within Arizona or the other basin states. Instead, all of the alternatives proposed by Reclamation to date have relied upon voluntary reductions in water supplies to U.S. water users to offset the bypass flows. These alternatives should not be considered permanent solutions because ultimately the water supplies to the basin states are reduced, a condition that will negatively impact water users in Arizona.

Environmental Issues

If drainage water from the Wellton-Mohawk District is reclaimed by the desalter, the water supply for the large brackish water Cienega de Santa Clara will be cut off. The wetland reportedly supports endangered species including eighty per cent of the Yuma Clapper Rail population of the world and a population of desert pupfish among many other terrestrial and aquatic species (Glenn, 2002). The importance of the Cienega is underscored by the designation of the Cienega and surrounding areas as a Mexican National Biosphere. Mexico employs several individuals to oversee the Cienega and guide natural history tours to view the fauna and flora. U.S. non-governmental interests also value the use of water for the Cienega. In recent years, the Defenders of Wildlife and several other non-governmental organizations have filed a lawsuit that contends that the U.S. is responsible for mitigating actions that might affect endangered species in Mexico (Defenders of Wildlife v. Babbitt).

When Minute 242 of the Treaty was negotiated, the drainage water from the Wellton-Mohawk District was considered to be unusable for a beneficial use in Mexico. Now Mexico has determined that the Cienega has biological value and some income is generated from tourists who visit the area. Some may argue that if this water has value to Mexico and is being used for a beneficial use, the water deliveries should be counted as a delivery of Treaty water. Making this interpretation is consistent with U.S. policy wherein water from the states' allocations is specifically allocated for National Wildlife Refuges. If Mexico accepted all or part of the water under the Treaty, the U.S. obligation to replace the bypass water would be reduced.

Mexico also has several options to offset the environment damages caused by the operation of the desalter. Several of the options to offset reduced inflows to the Cienega are described in a report prepared for the Packard Foundation (Clark, 2001). This report discussed options for obtaining water for the Colorado River Delta, but these same strategies and others could be used to supply the

Cienega. Land might be fallowed to conserve water to be allocated to environmental purposes. Drainage flows from Mexican farms might be diverted to the Cienega. Off stream storage facilities might be used to capture flood flows for use in the Cienega.

In conclusion, although it is very important to resolve the environmental impacts associated with the operation of the desalter, U.S. water users should not be penalized for the impacts. Mexico has many options to resolve the impacts, and perhaps the U.S. could assist Mexico with the maintenance of the new beneficial uses for environmental uses. Water supplies from the U.S. are not necessary to resolve the issues.

Economic Issues

Building and operating a desalter to provide water for Mexican agriculture has long been criticized as uneconomical (VanDerWerf, 1994). The representatives of the basin states felt the U.S. negotiators chose the desalter as an expedient to quickly reach an agreement with Mexico. Some of the basin state representatives felt that the U.S. would have been better served with an agreement that was based on a salt balance standard, a standard that would have capped the amount of salt that could have been returned to the river below Imperial Dam (DeMarsay, 1991). Such a standard would have been less costly to meet than desalinization. But after consideration of the U.S. foreign policy interests, the negotiators chose desalinization with full knowledge of the high costs. Making this choice committed the U.S. to a particular water management strategy that the Brownell Commission felt would provide the best long-term solution to meet the growing water demands in the southwest U.S. and Mexico. The costs of desalted water were and are undoubtedly too high for irrigated agriculture, but 30 years after Brownell reported the U.S. policy regarding salinity control, water treatment by desalinization is being actively considered for municipal and industrial water supplies in southern California. The benefits to desalinization for municipal water supplies include water supply augmentation by reclamation of poor quality water, reduced costs for customers who have to treat water before use and increased ability to recycle treated effluent water because the waste stream contains less salt. The cities of Tíjuana, Mexicallí and San Luís in Mexico might benefit greatly from direct deliveries of high quality, desalinated water that can be recycled after municipal use for agricultural or other purposes. In effect, desalinization could increase the water supply to Mexico. The economic evaluation of the value of the desalter to Mexico is outside of the scope of this report. But the evaluation of the economics of operating the desalter should consider the potential end uses other than irrigation. Such economic evaluations could form the basis for U.S./Mexico discussions about mutually beneficial water management strategies to meet growing urban water demands.

Perspectives Regarding the Historical Actions to Improve Salinity

The U.S. has attempted to resolve the salinity problems with Mexico in the spirit of international comity and cooperation. Mexico has benefited from the expenditure of large amounts of money within the U.S. for the reduction of irrigated acreage, improvement in farm management and irrigation efficiencies, and the construction of bypass canals and the desalter.

The Brownell Commission predicted that water conserved in both countries and supply augmentation were essential parts of the international water management agreements to meet the growing water needs in Mexico and the U.S. The Commission predicted that the U.S. would need to

reclaim the Wellton-Mohawk return flows by desalinization to meet the projected demand. These predictions have come true, water demand is at an all time high and Arizona can no longer accept the increased risk of loss of water supplies that is caused by the over delivery of water to Mexico. The full Arizona apportionment of Colorado River water is also necessary to meet the current water demand so that there is little or no capacity to use a water substitution method similar to the Coachella canal savings to balance the basin water budget. Water is being intensely managed in the lower basin. For example, Arizona and Nevada are expending large sums to recharge water supplies to protect against future shortages to municipalities. Intensive conservation programs are underway in all the lower basin states. California has initiated water transfers of unprecedented size from the agricultural sector to the municipal sector. If the U.S. continues to over-deliver water to Mexico, it will increase the risk of loss of basin water supplies. By increasing the risk of loss, the complex water exchange agreements, recharge projects and water allocation agreements that are necessary to meet the growing water needs of the basin become less certain.

Guy Martin, previous Assistant Secretary of the Interior for Land and Water Resources, summarized the problems inherent with all of the potential alternatives to full operation of the desalter:

> "There continues to be suggestions that work be discontinued on the desalting complex while more evaluations of alternatives are conducted...(t)hese alternatives are very similar to alternatives that were eliminated from consideration by Mr. Brownell and the task force during their evaluation of methods for meeting the agreement with Mexico. They basically represented water substitution-type schemes, which are not acceptable to the basin States, and further, they make the burden for the solution the responsibility of only the basin States rather than the Nation as a whole." (U.S. Congress, 1979).

Reclamation built the desalter at a cost of $256 million. It has spent over $100 million to maintain the plant over the last ten years, yet the desalter is not operating, water is still being bypassed to Mexico and no substitute water supply for the bypass has been identified and developed. Although the Salinity Control Act authorized studies and funds to identify feasible alternatives to replace the water bypassed to Mexico, the Yuma desalter remains the only option. Reclamation's analysis of the options concluded that the desalter was "...the only viable method of achieving the salinity differential as a permanent solution to the Colorado River International salinity problems..." and "...the only method acceptable to the United States interests."(USBR, 1973). But for the above average runoff between 1996 and 2000 that created surplus conditions, over 500,000 acre-feet of water would have had to have been released from storage to meet the over-delivery to Mexico because Reclamation has not operated the desalter.

The Salinity Control Act made it a "national obligation" to replace the water that is bypassed to Mexico so that the lower Colorado River basin states could meet the water demands within the U.S. Now that the interim period is over and the lower basin states need all of the water apportioned to them by the Colorado River Compact, Reclamation must act to eliminate or replace the bypassed water.

PART 2 - IMPACT ANALYSIS ON ARIZONA

Introduction

Reclamation has recently proposed several alternative actions to avoid operation of the desalter. All of the alternatives include continuing the delivery of water to Mexico in excess of the treaty requirements and offsetting the over-delivery by reducing water deliveries in the U.S. As illustrated by the history of the negotiations with Mexico, such solutions were intended to be interim measures until the desalter was built. Unfortunately, budget constraints are forestalling the operation of the desalter, making it necessary for Reclamation to extend the interim measures. The alternative actions to avoid operation of the desalter must also be temporary, to be replaced by a permanent solution that does not cause a loss of basin water supplies to the basin states.

The alternatives have economic and financial costs to Arizona. This section attempts to identify some of the costs and to describe the problems and issues that need to be considered for all Arizona water users. Many of the potential costs cannot be adequately quantified at this time, which means the risks associated with some of the alternatives cannot presently be quantified. It is anticipated that water users will be reluctant to accept alternatives that create unknown risks to the water supplies because the impacts of water supply shortages are so significant.

The method for analyzing the impacts of the alternative actions begins with a qualitative description of the basic alternatives for offsetting the desalter bypass and a description of the associated problems and issues for each strategy. Following the qualitative description of issues, the quantitative analysis presents estimated damages to Arizona water users caused by a reduction in water supplies to Arizona. The reduction in water supplies may either be caused by increased shortages due to the depletion of water supplies from Lake Mead, or a direct reduction of water supplies available to Arizona caused by a reduction in the state's allocation. A direct reduction in water supplies occurs if Reclamation retires agricultural land and arranges for a district to forbear its entitlement so the water may be delivered to Mexico. The estimated damages due to increased water supply shortages are displayed in present value amounts, the amount that would have to be paid today to offset future damages. The costs to make direct reductions of the water supply are analyzed differently. These costs are estimated based on the price of water currently being charged in California for the proposed water transfers under the California Colorado River Plan and then compared to the annual operating costs of the desalter.

Two general sets of alternatives can be used in combination to offset the desalter bypass flows. The first is to reduce the bypass obligation. The second is to offset the impacts on Lake Mead from the over-delivery to Mexico by reducing water deliveries in the lower basin. A third alternative that has been proposed by Reclamation is to use deficit accounting practices to postpone offsetting the desalter bypass flows, then taking action at a later date to reduce the impact to water users. Each alternative has several inherent problems and issues that reduce their overall acceptability.

Alternative - Reduction of Bypass Flows

Reducing the outflow in the Main Outlet Drain Extension (MODE) that delivers the Wellton-Mohawk return flows to Mexico may be accomplished in three ways. The drainage water from the district might be reduced through conservation or land retirement within the Wellton-Mohawk

District. The MODE flows might be reduced by diverting some of the water to be used for delivery to Mexico via the Colorado River. Or, the desalter can be fully or partially operated to reclaim up to 73% of the MODE bypass flow.

Conservation in the Wellton-Mohawk District. Water conservation and land retirement within the Wellton-Mohawk Irrigation District, actions that were proposed by Brownell and authorized by the Salinity Control Act, caused significant reductions in return flow from the Wellton-Mohawk District. In fact, the water savings have probably surpassed the expectations of the negotiators of Minute 242. Since 1998 the District has further cut outflow at the request of Reclamation to below the plant design inflow of 108,000 acre-feet. Reclamation reports that the bypass return flows from the district ranged from 125,476 acre-feet in 1995 to 68,601 in 2001 (USBR). (See Table 1) Further reductions in drainage pumping will probably require additional reductions in irrigated acreage.

The opportunity to conserve water in the Wellton-Mohawk District is probably limited. Very efficient irrigation systems, including level basin and sprinklers, are used by all the farms in the District. The District has reduced its irrigated acreage by retiring 12,000 acres since 1975. Further conservation savings or acreage reductions are possible but have not been quantified at this time.

The willingness of landowners in the Wellton-Mohawk District to conserve more water or reduce return flows through land retirement or leasing is unknown at this time. Therefore the overall potential for flow reductions and the direct costs of this strategy are unknown. Surveys will have to be completed to obtain this data.

If the consumptive water use is reduced to reduce the Wellton-Mohawk return flows, other Colorado River water entitlement holders within Arizona will request the water. In particular, CAP will request the water. Even if Arizona water users did not request the water and the State did not use its full 2.8 million acre-feet apportionment, other lower basin states would request the unused water for use by their entitlement holders. The cost of land retirement or water savings must include the costs to arrange forbearance by lower priority water users. Besides the increased costs, there is no clear legal or administrative mechanism that allows this alternative to be implemented. At a minimum, new federal rules and concurrence by the state legislatures will be necessary.

Diversion of MODE flows. The amount of bypassed water might be reduced by diverting some of the water from the MODE into the Colorado River when the water quality and quantity of river flows are sufficient to dilute the drainage water enough to meet the annual average salinity differential between Imperial Dam and Morelos Dam that is required by Minute 242. Reclamation has apparently already taken this action, and its feasibility is limited. Mixing can only occur during a few weeks of the year and is not possible in years when the average differential is at or near the maximum allowed by the Minute (USBR, 2002).

Blending MODE water with Colorado River water for delivery to Mexico depends on the projected annual average salinity differential. At this time, Reclamation must closely monitor salinity and manage inflows to the river to meet the required salinity differentials of Minute 242. In previous years, Reclamation has had more flexibility especially in the summer months when water deliveries to Mexico have been at maximum. The possible future reductions in MODE flows have not been estimated.

Operation of the Desalter. Operation of the desalter reduces the bypass significantly for every acre-foot of water that is treated. Even partial operation of the desalter could decrease the federal obligation to find replacement water supplies. Reclamation estimates that 73% of the water that is treated may be reclaimed. For example, if the desalter were operated at one-third capacity, which is the current standby condition required by Congress, the bypass would be reduced by 26,000 acre-feet.

Start-up of the desalter will require at least a one-year to operate one-third of the plant. Full operation may take two years or longer depending on the availability of congressional funding.

Alternative - Offset Over-delivery to Mexico

If annual lower basin water uses are reduced below the amounts allowed by the Interim Surplus Guidelines or normal water supply conditions, the "saved" water may be used to offset the over-delivery to Mexico similar to the Coachella canal savings. The primary ways to reduce the lower basin consumptive uses are by land fallowing and conservation. Reclamation has also proposed to recharge and store Colorado River water in off-stream storage sites during surplus years, then use the stored water in normal years to offset the bypass. Both methods are expensive and have significant legal and institutional problems.

Conservation. Reclamation has proposed to acquire water through conservation. Water conservation is the method proposed to be used by the Imperial Irrigation District (IID) to obtain enough water to transfer up to 200,000 acre-feet to San Diego County. Participating farmers in the Imperial Irrigation District will make the water available by implementing extraordinary conservation measures to reduce the diversions of the district. San Diego has agreed to pay approximately $249 per acre-foot, indexed upwards over the 45-year life of the agreement (IID, 2002). The transfer of the conserved water is carried out under the authority of California state law governing water transfers. The transfer must also be approved by Reclamation.

Palo Verde Irrigation District has recently signed a contract to fallow lands with the Metropolitan Water District of Southern California (MWD). In this case, the farms are offered $3,170 per acre for the right to annually fallow lands anytime in the next 35 years (MWD, 2002). If the lands are fallowed, the farm will be paid $550 per acre per year. The total water supply that may be transferred has not been quantified, but for the purposes of this report it is assumed to be about 4.5 acre-feet per acre. MWD reports that between 25,000 and 111,000 acre-feet of water may be transferred annually under this agreement. The costs per acre-foot are not easily compared to the IID to San Diego agreement, but could be somewhat lower depending on the amount of water that MWD orders. The Palo Verde - MWD agreement is not a permanent water transfer, but a temporary and intermittent transfer that is only implemented when MWD has an extraordinary need for water. In addition to the direct water costs, MWD reports that it will invest $6 million in local community improvements, pay $500,000 for environmental documentation, and pay $100,000 per year for administrative costs to the Palo Verde Irrigation District.

Theoretically, there is significant opportunity to reduce water uses in the U.S. through land fallowing. Over 5 million acre-feet of water are consumed for irrigated agriculture in the lower basin of the Colorado River. However, water transfers to meet growing urban and environmental

needs in the U.S. will compete for the available water. Within 15 years, California will have to reduce agricultural water uses by over 600,000 acre-feet to comply with their lower basin apportionment. To meet the water demands within MWD, all of this water will have to be transferred from agriculture. California districts have been very cautious about entering into permanent, open-ended agreements to transfer these quantities of water. Although there does not appear to be a physical constraint to obtaining another 100,000 acre-feet to offset the bypassed water to Mexico, there are economic and institutional constraints as described below.

Administrative rules may need to be adopted to provide adequate accounting and compliance for the implementation of this alternative. Water savings will have to be measured and accounted for properly to assure that the savings offset any bypass flows. As demonstrated by the historical actions surrounding the canal savings for the Coachella Canal, this issue will require significant changes to current administrative procedures.

Any agreement with an irrigation district or other party to save water must also be enforceable. Overruns must be minimized and avoided.

Again even if land is fallowed and water is conserved, other water users in the lower basin will request the water. If higher priority water users, for example Palo Verde Irrigation District, saves water through fallowing, lower priority water users within the same state and within other states must agree to forebear use of the water that is saved. As stated before, no legal mechanism is in place to implement this alternative.

Within California and Arizona, there has been reluctance in the past to fallow land to save water for transfer to other parties. This attitude may be changing, but surveys of the districts are needed to ascertain the potential for fallowing enough acres to create over 100,000 acre-feet of saved water supplies. The potential costs for conserved water is unknown, but appears to be substantial based on California examples. Competition from the urban water providers may increase the costs over time for obtaining water. Types of conservation actions that are acceptable to the districts are also not known. Some districts may not attempt to fallow lands, but simply reduce the overall application of water to their member lands. These types of proposals increase the difficulty of accounting and measuring the effectiveness of proposed water conservation and transfer actions. More specific proposals need to be described before an informed decision can be made about the feasibility of using land fallowing or extraordinary conservation to save water.

Recharge Surplus Water or CAP Water. Reclamation has indicated that water might be recharged in underground storage facilities during surplus years and the stored water might be used to offset the over-deliveries to Mexico in normal years. In effect, Reclamation is proposing to use off-stream storage and recovery methods similar to the interstate water banking agreements now in use between Arizona and Nevada.

A variation of the recharge option is to use CAP water purchased through an excess water agreement with the project. The problems and economic analysis for this option are similar to recharging surplus water.

The capacity of recharge sites may be limited within the lower basin. Limited site capacity in Arizona has restricted the ability of the Arizona Water Banking Authority (AWBA) to recharge all of the water supplies available to it. The limitations on recharge sites will affect the lead times to implement these types of strategy. Capital costs to recharge will have to be incorporated into the economic analysis.

Recharge by Reclamation may directly compete with instate and interstate water banking projects within Arizona. Orders for surplus water or CAP water for banking by Arizona entities or the basin states have a higher priority than use by Reclamation for federal purposes. Because Nevada and California are seeking to store water through interstate off-stream-banking, it is very possible that water supplies available to Reclamation may be limited.

Wheeling agreements and site utilization agreements must be implemented. There may be limitations on the availability of space to wheel water for Reclamation. The agreements will add to the lead-time and the cost of recharge.

Excess water within the CAP may not be available to Reclamation after 2002 because other water users including the AWBA will fully utilize all of the excess water within Arizona.

Surplus conditions are not predictable and may not occur within the next few years.

Some have raised a concern that Reclamation may have to have additional congressional authorization to use off-stream storage as part of the operations of the Colorado River.

Deficit Water Accounting

A temporary deficit account has been proposed by Reclamation while it implements one or more of the alternatives to operation of the desalter. Reclamation is proposing to operate the river on the presumption that either a large runoff will eliminate the deficit, or that enough surplus water can be recharged to deliver a full supply of water to the CAP to offset the impacts of a shortage. This proposed "insurance policy" does not adequately provide for the loss of surplus water and creates a risk that not enough water will be available in off-stream storage to mitigate shortages to Arizona water users. This practice can lead to extreme legal and political conflict as is illustrated by the Rio Grande/Rio Bravo situation in 2002 (Texas, 2002).

The main purpose for using deficit accounting practices is to postpone actions that actually conserve water supplies in Lake Mead. Some lead-time is needed to obtain funding and other arrangements to implement any of the alternatives. But the deficit accounting should only be used to quantify the obligations of the federal government while the water conservation actions are being implemented. A comparison of the problems and issues for the different bypass strategies indicates that operation of the desalter may in fact be easier to accomplish than other strategies.

Summary of Problems and Issues for Strategies to Offset the Bypass

Annual Operating Costs for the Desalter	Water Conservation & Agricultural Land Fallowing	Federal Groundwater Recharge
1. Environmental impacts to the Cienega de Santa Clara.	1. The willingness to participate by the districts and farms is unknown.	1. The opportunities to obtain water from surplus supplies may be limited during the next five years or more.
	2. The total costs for fallowing are uncertain.	2. Will need to develop recharge site capacity.
	3. Past accounting practices have been inadequate to verify water reductions.	3. The probability of flood flows for use by environmental programs will be reduced.
	4. Environmental costs may be very large.	4. May need Congressional authorization to use off-stream system storage.
	5. Timeframes for environmental compliance may be very long.	5. Will need wheeling agreement with CAP.
	6. Creates Federal competition for Colorado River water supplies. The CAP may have need for the water not used by the mainstream districts, thereby limiting the supply available for Federal uses.	6. Will need agreement to recover and substitute recharge water as project water.
		7. Creates competition with other water customers including interstate, AWBA and CAGRD

Water Supply Analysis

Introduction

Two types of water supply shortage will occur if the desalter is not operated and non-Colorado River sources of substitute water supply are not found to replace the bypass effluent of the plant. First, if the over-delivery to Mexico continues, then there is an increased likelihood of shortage to the CAP and some mainstream water users. If this happens, water supplies to non-Indian and Indian agriculture and urban uses will be shorted.

Second, if part of Arizona's apportionment is diverted to Mexico, less water will be available to the CAP to meet water demands. This means that less water will be available to meet urban groundwater replenishment demands, water banking demands, and Indian and non-Indian agricultural demands.

In order to quantify the worst case impacts of not replacing the bypass flows, the risk of shortage and reductions of surplus are estimated using Reclamation's Colorado River operation model (CRSSEZ). The estimate of water supply to the CAP is dependent on several assumptions about the operation of the river reservoirs. The variables and assumptions are discussed below.

Shortage Analysis

Currently, there are no specific hydrologic or reservoir operating criteria for the determination of shortage on the Colorado River. Therefore, for this study a range of shortage operating criteria is assumed to estimate the range of impacts of a shortage. When the CAP water supply is projected to be shorted, the current operating assumption is that diversions will be cut by 500,000 acre-feet. (This is not a set amount, but an approximation).

Because the lower basin is currently fully developed, continued over-deliveries to Mexico will deplete water from storage except during years of flood control releases. If the water surface elevations are lowered by the continued over-deliveries, reductions to surplus deliveries for California and Nevada will be triggered by the Interim Surplus Guidelines (ISG) prior to 2016. Under the ISG, some water deliveries to MWD will be curtailed if the elevation of Lake Mead drops below 1145 feet mean sea level (fmsl). At some point below 1125 fmsl, Reclamation will have to declare a normal water supply condition and reduce the surplus deliveries to California and Nevada, limiting the lower basin states to 7.5 million acre-feet.

After the expiration of the ISG, shortages will occur based on the chosen operating criteria for the reservoirs. Several examples illustrate the range of shortage criteria in the years following the expiration of the ISG. From the perspective of Arizona water users, river shortages should not be declared unless Lake Mead is projected to empty (elevation less than 900 feet mean sea level). However, the Southern Nevada Water Authority may argue that shortages should be declared to preserve enough water in Lake Mead to allow continued operation of its water intakes, between elevations 1000 and 1050 feet mean sea level (fmsl). Currently the standard for long-range forecasting using the model assumes these water elevations to calculate the shortage criteria. MWD of Southern California might request that Reclamation use shortage criteria that limits Arizona and

Nevada water users when reservoir levels are even higher, leaving more water in storage to protect its users from a shortage. Environmental concerns may also influence the shortage criteria, but no specific information is available to evaluate.

For the purposes of this study, shortage criteria were assumed for protection of Lake Mead elevations at 1000 fmsl to reflect the lower end of the shortage criteria, and 1100 fmsl to reflect a higher protected elevation. These elevations are used only for purposes of comparison. Neither elevation is endorsed by ADWR as operating criteria.

Surplus Analysis

Depleting the water stored in Lake Mead will reduce surplus water deliveries. Based on the amounts of water diversions over the last several years, less surplus water could impact agriculture in southern California. Water supplies for interstate and intrastate banking will be reduced. Surplus deliveries to Mexico will not occur as often, resulting in less water for agriculture, municipal and environmental purposes.

Water is normally released to make space for probable high flows, or to avoid flood control releases. During the next 15 years, quantified surpluses may be released to avoid projected flood control releases. The quantified surplus release is intended to avoid projected flood control releases in any year when the 70^{th} percentile (70R) runoff is assumed for the next year of operation. Water may be used to meet any downstream water orders, including Mexico's, but the release is quantified and may not be sufficient to meet all water demands. After the expiration of the ISG, the criteria for spill avoidance are expected to remain at 70R. Arizona supports the 70R assumption because it keeps the reservoirs as full as possible, thus prolonging the time before a shortage is declared. California has historically asked to use more water in the reservoir to meet its demands in excess of its apportionment of 4.4 million acre-feet. For this analysis, after the expiration of the ISG both 70R and 60R surplus criteria are assumed. The two surplus criteria are used only for the purpose of comparative analysis in this report.

Economic Perspectives

Damages to Arizona Water Users

Economic damages will result if increased shortages occur due to not operating the desalter. Examples of damage include the loss of agricultural production in central Arizona, and greater expenditures to purchase replacement water supplies for municipal and industrial water users. Municipal water providers may have to increase water banking activities to offset future shortages. Alternatively, the municipalities may have to purchase water entitlements from mainstream entitlement holders, just as San Diego and MWD of Southern California have.

Loss of agricultural output will occur in central Arizona on Indian and non-Indian lands. Non-Indian irrigation districts have some capability to offset shortages by operating groundwater wells, but the districts report that they do not have enough capacity to offset the complete loss of CAP water during a shortage. Based on discussions with representatives of the districts, a shortage declaration may reduce water supplies between one-half and one-third of the normal CAP supply. Indian lands

may have a larger impact because there is less back-up capability to use groundwater (ADWR-Pinal AMA, 2002).

Lost agricultural output is expected to be $1,330 per acre in 2002 dollars. The calculated loss was based on the average crop mix and economic returns for central Arizona farms (AWDR, 2002). Assuming a water delivery of 4.5 acre-feet per acre, the computed damages for the loss of one acre-foot of water is approximately $295. Because some of the lost CAP water can be replaced by groundwater, the actual water loss is only between 35% and 50 % of the CAP shortage. It was assumed for the purposes of this study that the non-Indian districts would replace half of the CAP, but that Indian districts would not be able to replace the lost water during a shortage. For the purposes of this study, it was assumed that the combined agricultural water loss during a CAP shortage would result in a water supply reduction of 65% to Indians and non-Indians. This factor was chosen to account for the possible loss of non-Indian priority water that may be allocated to the tribes in the future.

Irrigation districts on the mainstream with entitlements coequal in priority to the CAP will also lose part of their water supplies during a shortage. For mainstream agriculture the lost water cannot be replaced, so the computed damages are assumed to be $295 per acre-foot. See Appendix C for a description of the assumptions for calculating the expected damages caused by a water shortage.

The cost of replacing municipal water supplies reflects the damages expected for M&I water users. The costs for replacement water were estimated based upon assuming accelerated recharge for water banking and alternatively, the costs for water transfers for the San Diego Water Authority and MWD transfers.

The groundwater recharge costs were based on the preliminary 2003 water rates for the Central Arizona Project and a recharge site use rate of $45 per acre-foot, which is consistent with the Vidler recharge site. The delivery rate is estimated to be at the Excess Water Rate, which includes energy costs that range from $31 to $48 per acre-foot. The descriptions of the assumptions are found in Appendix C.

Table 2 displays the comparative damages that are estimated as a result of not operating the desalter. The two alternatives represent the minimum and maximum shortages of the four alternative water supply projections that were tested. The damages shown in Table 2 would be the direct consequence to Arizona water users from not operating the desalter. Other impacts may expected that cannot be easily quantified, including environmental impacts and actions taken by water users to avoid the unknown risks that water shortages create.

Table 2
Estimated Damages Due to Not Operating the Yuma Desalter

Total CAP Shortage for 100 years	*Total Damages Assuming Replacement by Recharge for M&I* [1] *(in $Thousands)*	*Total Damages Assuming MWD Water Transfer Costs for M&I (in $Thousands)*	*Total Damages Assuming San Diego Water Transfer Costs for M&I*[2] *(in $Thousands)*
Assuming Short/Surplus Alt. #2 (80P1100/70R) M&I 1,800,580 AF Short	Agriculture $56,309[3] Municipal $236,410 **Total $292,719**	Agriculture $56,309[4] Municipal $76,991[4] **Total $133,300**	Agriculture $56,309[4] Municipal $88,620 **Total $144,929**
Assuming Short/Surplus Alt. #3 (80P1000/60R) M&I 2,199,340 AF Short	Agriculture $52,393[5] Municipal $288,770 **Total $341,163**	Agriculture $52,393[6] Municipal $94,554[6] **Total $146,947**	Agriculture $52,393[6] Municipal $112,450 **Total $164,843**

Comparison of the Costs of Alternatives to the Desalter

Baseline Condition – Operation of the Desalter

Operation of the desalting plant is the baseline condition that was expected when the Treaty with Mexico was modified by Minute 242 and Congress subsequently passed the Salinity Control Act to implement the measures referred to in the Minute. Operation of the desalter included the federal obligation to augment the river to offset the effluent bypass.

Reclamation estimates the cost of operating the desalter to be between $28,000,000 to $36,000,000 per year (USBR, 2002).

Salvage Water by Land Fallowing or Conservation

The costs of offsetting the bypass by reducing the lower basin water uses through water conservation or land fallowing were estimated assuming the water charges for the transfer of Colorado River water from IID to the San Diego Water Authority. Because the CAP could order the water that is saved, an additional cost is added to this alternative to offset the loss of water to the CAP. If water is available to the CAP, the value to the CAP is estimated to be same as the price being paid by San

---

[2] See Appendix C, Table C–8 for M&I calculation, assumes $171 per AF to be recharged within 15 years
[3] See Appendix C, Table C-7 for M&I calculation
[4] See Appendix C, Table C-9 for Agriculture calculation
[4] See Appendix C, Table C-5 for M&I calculation
[5] See Appendix C, Table C-10 for Agriculture calculation
[6] See Appendix C, Table C-6 for M&I calculation

Diego. This valuation is assumed to reflect willingness to buy and sell Colorado River water entitlements for an interim period of time.

Groundwater Recharge for Federal Purposes

The cost for groundwater recharge was calculated based on the cost of CAP water and the cost for recharge. The CAP water costs were based on a range of CAP water rates from the rates paid for interstate banking and the rates paid for excess water contracts. Interstate water banking rates are based upon the costs for energy, CAP operations (a.k.a. fixed operation, maintenance and replacement), in-lieu property taxes and capital repayment. The excess water rates include costs for capital repayment, energy and fixed OM&R. The recharge rates were based on a range of costs for use of currently available recharge sites. In addition to the water rates, an additional wheeling rate was estimated. The CAP has no wheeling policy or proposed rate, therefore the wheeling costs may not reflect the actual future charges. The description of the calculation for the cost to recharge water is included in Appendix D.

Summary of Comparative Costs for Alternatives

The summary of the comparative costs for each alternative is shown in Table 3. The costs presented for the alternatives are the annual costs to either desalt 108,000 acre-feet of water or to replace the same amount of water through land fallowing or off-stream storage. The estimated economic costs are approximations and may vary considerably. In general, the increased competition for use of recharge and conveyance facilities and water supplies will create unforeseen future costs to water users as the demand for municipal and industrial water supplies grow. For this reason the comparative costs shown in Tables 2 and 3 may understate the value that water users will assign to the loss of water caused by not operating the desalter.

Table 3
Comparison of Desalter Operational Costs to Alternative Actions

Annual Operating Costs for the Desalter	Water Conservation & Agricultural Land Fallowing	Federal Groundwater Recharge
$28,000,000 to $36,000,000[7]	$53,704,000[8]	$38,208,000[9]

[7] USBR, 2002

[8] Assumes $248.63 per AF and indexed, the same as the Imperial Irrigation District to San Diego lease of 2001, and 108,000 AF /Year purchase. The fallowing costs assume that the area that is fallowed is paid $26,852,000 and the CAP will be paid $26,852,000 to forbear.

[9] Assumes $259 per AF for 120,000 AF to be banked per year and $66 per AF for recovery of 108,000 AF per year. See Appendix D for assumptions.

Conclusions and Recommendations

A full review of the historical agreements and the economic feasibility of the alternatives for the improvement of salinity at the international border with Mexico indicates that operation of the Yuma Desalinization Plant is still the most effective action that Reclamation can take to meet the requirements of Minute 242 of the 1944 Treaty with Mexico. The history of the development of Minute 242 clearly shows that bypassing water in excess of the Treaty requirements was rejected as a permanent solution to the salinity issue due to the severe water supply impacts on U.S. water users and Arizona in particular. Relying in good faith upon the historical agreements made by the federal government to protect the basin water supplies, the Colorado River Basin States have allocated water and invested in water distribution systems to serve large municipalities, Indian tribes, agriculture and the environment. The Salinity Control Act of 1974 authorized the desalter as the means to fulfill the national obligation to mitigate the risk of water supply shortage to U.S. water users.

Continuation of the bypass to Mexico will cause significant economic damages to Arizona water users. If the desalter is not operated, it is estimated that the damages to Indian and non-Indian agriculture and municipalities could exceed $635 million in the next century, or a present value of $341 million.

To better manage water supplies on the Colorado River, Reclamation must immediately begin to properly account for all water that is bypassed to Mexico. Replacement of this water is an U.S. obligation under the Salinity Control Act. The interim period whereby Reclamation could use the conservation savings from the lining of the Coachella Canal to offset over-deliveries to Mexico has ended. The interim period ended in 1979 when the deliveries to the lower basin states exceeded 7.5 million acre-feet. Even though the interim period was not ended by the Secretary in that year, the interim period is now over because restrictions have been placed on the amount of water available to California water agencies pursuant to the adoption of the Interim Surplus Criteria.

Although the desalter is costly to operate, alternatives to the operation of the desalter may be more costly than operating the plant. Using the current market costs for recharging water results in a cost of $38 million and the lease/purchase of Colorado River entitlements to replace the bypass may cost $54 million. By Reclamation's estimates, the cost of operation of the desalter ranges from $28 to $36 million, making it an economical means to obtain water. Examinations of the other institutional and physical constraints for the alternatives indicate that some of the alternatives proposed by Reclamation are not feasible substitutes for the desalter. For example, if surplus water supplies are not available for off-stream storage for several more years then the desalter may be a more timely solution to offsetting the bypass. Also, as illustrated by the Imperial Irrigation District/San Diego Water Authority water transfer, fallowing irrigated land and transferring water have potentially large costs for environmental compliance making the desalter a more economical choice. Furthermore, state law and the Seven-party Agreement allow the proposed water transfers within California. But no legal mechanism currently exists that allows the U.S. to use water from the lower basin apportionments for delivery to Mexico. It could easily take years to obtain such authority, if it is even possible. Other alternatives pose unknown, but substantial risks. For example, using water accounting practices that allow water deficits often leads to water shortages in drought years. An extreme example of the problems caused by deficit accounting is illustrated by the current problems on the Rio Grande/Rio Bravo in water year 2002. For these reasons, Arizona generally opposes the

use of a permanent water deficit accounting system to substitute for physically replacing the bypass obligations.

If the institutional constraints can be overcome, partial, interim solutions might be employed until a permanent solution is implemented. Interim solutions, however, must be part of a comprehensive plan that leads to a permanent solution to reduce the impacts of the over-deliveries to Mexico. The interim solutions can only be adequately evaluated within the context of an overall plan. Reclamation should therefore prepare a comprehensive plan to replace the water over-delivered to Mexico since 2001. The plan should include actions to reduce the over-delivery as much as possible during the next five years. Reclamation should also include actions to offset projected cumulative over-deliveries. These actions should begin by 2003. If Reclamation intends to propose interim solutions to meet the replacement obligation, Reclamation should establish an explicit timeframe in which it will cease to use U.S. Colorado river basin water supplies to meet the Mexican salinity requirements under Minute 242. Budget authorization should be requested immediately to implement the plan.

Reclamation, the International Boundary and Water Commission and Mexico should jointly investigate and implement actions that can be taken in Mexico to resolve the desalter issues. Many opportunities exist in Mexico to offset the loss of system water from the bypass flows. The Cienega de Santa Clara now provides a significant beneficial use to the Mexican economy and environment. If the bypass water is being beneficially used, it should be counted as a delivery under the treaty and the desalter would not be needed. On the other hand, Mexico might choose to have the desalter operated to provide a significantly higher quality water supply for use by cities and industry in Mexico. This action provides additional benefits to Mexico because a high quality water supply can be recycled for other uses, thus effectively increasing the water supply. If the desalter is operated and Mexico still wants to retain the benefits of the Cienega, water can be supplied for that purpose by Mexico through land fallowing and conservation. For the last three decades, Mexico has received benefits from the bypass of Wellton-Mohawk return flow and the expenditure of hundreds of millions of dollars in the U.S. to reduce the salinity of the Colorado River. Additional benefits to Mexico should come from improved water management in Mexico, not from additional water supplies from the United States.

References

ADWR, 2002. Arizona Department of Water Resources. File analysis prepared by Michael Hanrahan utilizing data from *Arizona Agricultural Statistics 1998, 1999, 2000; Arizona Annual Crops, February 2001, 2002; University of Arizona Crop Budgets 1999-2000;* and, personal communications with the Environmental Working Group and other U of A researchers.

ADWR, 2002. Arizona Department of Water Resources. File analysis prepared by Deanna Ikeya of the water supply conditions on the Colorado River utilizing the USBR – CRSSez River Operation Model, and analysis of the impact of shortage to Central Arizona Project subcontractors.

ADWR, 2002. Arizona Department of Water Resources. Personal Communication with Randy Edmond, Pinal AMA.

AWBA, 2002. Arizona Water Banking Authority. Draft Annual Plan of Operation.

Brownell, Herbert, 1972. *Report of the President's Special Representative for Resolution of the Colorado River Salinity Problem With Mexico, December 28, 1972.*

CAP, 2002. Central Arizona Project. Preliminary 2003 Water Rate Schedule.

Center for Biological Diversity, et al, 2001. A letter to Robert Johnson, Director of the Lower Colorado River Region from David Hogan Center for Biological Diversity et al Dated July 6, 2001.

Charney, Alberta and Gary C. Woodard, 1990. "Socioeconomic Impacts of Water Farming on Rural Areas of Origin in Arizona". *American Journal of Agricultural Economics.*

Clark, Jo, et al, 2001. *Immediate Options for Augmenting Water Flows to the Colorado River Delta in Mexico.*

CRBSCF, 2002. Colorado River Basin Salinity Control Forum. *2002 Review, Water Quality Standards for Salinity, Colorado River System, Draft June 2002.*

CVWD, 2002. Coachella Valley Water District WEB page www.cvwd.org/water&cv.htm

Defenders of Wildlife, 2000. Defenders of Wildlife v. Bruce Babbitt, Secretary of the Interior

DeMarsay, Anne, 1991. *The Brownell Task Force and the Mexican Salinity Problem: A Narrative Chronology of Events, Submitted to the Colorado River Basin Salinity Control Forum, September 1991.*

Gollehon, Noel R. "Water Markets, Implications for Rural Areas of the West". *Rural Development Perspectives, Vol. 14, no. 2.*

Holburt, Myron B., 1975. "International Problems of the Colorado River". Natural Resources Journal, Vol. 15, no. 1, January 1975.

Imperial Irrigation District, 2002. "Water Transfer Agreement between the Imperial Irrigation District and the San Diego Water Authority", http://www.iid.com/water/transfer.html.

International Boundary and Water Commission, 2001. *A Report on Salinity Operations on the Colorado River Under Minute 242, January 1 – December 31 1999, June 2001.*

Los Angeles Times, 2001. MWD, Farmers Near Deal for Water, http://www.times.com,

July 7, 2001

Mumme, Stephen P. and Ismael Aguilar Barajas, 2002. "Managing Border Water to the Year 2020: The Challenge of Sustainable Development." A paper presented at Border Institute IV, sponsored by the Southwest Center for Environmental Research and Policy, Rio Rico, Arizona. May 6-8, 2002.

MWD, 2002. Metropolitan Water District of Southern California WEB page www.mwd.dst.ca.us

Pitt, Jennifer, 2001. "Can we restore the Colorado River delta". *Journal of Arid Environment, Vol. 49, no. 1, September 2001.*

Pub.L. 93-320. Colorado River Basin Salinity Control, June 24, 1974.

Texas, 2002. "Behind the U.S.-Mexico Water Treaty Dispute". The Interim News published by the Texas House of Representatives Research Organization, Number 77-7, April 30, 2002.

U.S. Congress, 1974. Congressional Record – Testimony on H.R. 12165, Pages 18788-18800, June 11, 1974.

U.S. Congress, 1979. 97th Congress, House of Representatives, Subcommittee on Water and Power Resources, Testimony on H.R. 2609, March 20, 1979 at 2,3, and 11.

U.S. Congress, 1995. 103d Congress, House of Representatives, Energy and Water Development Appropriation Bill, Report 103-533.

U.S. Congress, 1999. 106th Congress, Senate Energy and Water Development Appropriation Bill, Report 106-58.

U.S. Congress, 2002. 109th Congress, House of Representatives, Energy and Water Development Bill, Report.

U.S. Mexican Water Treaty, 1944. The Mexican Water Treaty of 1944: Treaty Series 994 (59 Stat. 1219). Including Minutes 218, 241 and 242.

USBR, 1973. U.S. Bureau of Reclamation, *Colorado River International Salinity Control Project, Special Report*, September 1973.

USBR, 1977. U.S. Bureau of Reclamation. *Colorado River Basin Salinity Control Project, Title I Division, Status Report.*

USBR, 1990. U.S. Bureau of Reclamation, Gila Project, Supplemental and Amendatory Contract between the United States and the Wellton-Mohawk Irrigation and Drainage District, Contract No. 1-07-30-W0021, Amendment No. 1.

USBR, 2001. U.S. Bureau of Reclamation, Colorado Interim Surplus Guidelines, Federal Register, Vol. 66, No. 17, Thursday, January 25, 2001.

USBR, 2002. Draft Report to Congress By the Secretary of the Interior. *Modifications to Title I of the Colorado River Basin Salinity Control Act.*

USBR, 2002. U.S. Bureau of Reclamation. Personal Communications with staff at the Yuma Area Office

USBR. U.S. Bureau of Reclamation. *Compilation of Records in Accordance with Article V. of the Decree of the Supreme Court of the United States in Arizona v. California Dated March 9, 1964,* Calendar Years 1964 through 2001.

USDA-SCS, 1988. U.S. Department of Agriculture, Soil Conservation Service. *Wellton-Mohawk On-Farm Irrigation Improvement Program - Post-Evaluation Report. Wellton-Mohawk Project Report.*

VanDerWerf, Martin, 1994. "Draining the Budget to Desalt the Colorado." *High Country News,* February 21,1994.

Wilson, Paul N., 1992. *An Economic Assessment of Central Arizona Project Agriculture, A report submitted to the Office of the Governor and the Arizona Department of Water Resources, November 1992.*